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Outbursts on comet 67P/Churyumov– Gerasimenko

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Abstract

The optical, spectrocopic and infrared remote imaging system (OSIRIS) onboard the *Rosetta* spacecraft provided first-hand information on the outbursts from comet 67P/Churyumov–Gerasimenko. In this paper, we upgrade the investigation on the physical properties of the outbursts from July 2015 to September 2016. The new map of the source regions from the detected outbursts has been used for the comparison to the measurements from the other onboard instruments.

1. Introduction

The optical, spectrocopic and infrared remote imaging system (OSIRIS) scientific imaging cameras on the Rosetta spacecraft have been monitoring the coma activity of comet 67P/Churyumov–Gerasimenko (67P hereafter) since their orbital rendezvous in 2014 August. The solar heating of the sunlit side of the nucleus surface leads to sublimation of the volatiles and to the formation of dust jets. On 2015 March 12, a small outburst was first detected from a part of the Imhotep region on the night side. Such mini-outbursts or night-side activities have been observed before at comet 9P/Tempel 1 by the Deep Impact mission and comet 103P/Hartley 2 by the EPOXI mission. Shortly before the close approach to comet 9P/Tempel 1, the high-resolution camera on the Deep Impact spacecraft found a number of small, well-defined jets whose bases were rooted at the nucleus surface. Some of these, called limb jets, appeared to come from the darker regions and appeared to be associated with the ice patches. A later mission of the Stardust–New Exploration of comet Tempel 1 (NExT) imaging of 9P/Tempel 1 allowed us to connect the jets with cliffs. Comet 103P/Hartley 2 also displayed several narrow jet features emitting from the un-illuminated regions beyond the terminator at the time of the flyby observations. Unlike the less certain identification of the source regions on Tempel 1, the source region of the nightside jets of 103P/Hartley 2 could be clearly traced to some rough surface topography. However, the mechanism for this type of activity is still unknown. Fortunately, unlike the snap shots from the previous flyby observations, the OSIRIS measurements can provide precise information on the timing and location of the outbursts via a time series of high-resolution images. After the first detection in 2015 March, the OSIRIS wide-angle camera (WAC) and narrow-angle camera (NAC) captured another outburst in mid-July of 2015. Since then, many more outbursts from the nightside and sunlit regions have been detected, with most of their source regions located in the Southern hemisphere of comet 67P. The detected outburst events show a variety of morphological features that can be classified into three different types: broad fans, narrow jets and complex plumes. In this work, we investigate the morphology of these events and characterize their physical properties in detail, including the surface brightness profiles, ejected mass and speed if there are two or more sequential images acquired by the same filter in short duration during the time frame of the outburst [1].

2. Methods

The software, shapeviewer, provided by Vincent (2016) is used to find the source regions of the detected outbursts. Notice that some of the outburst plumes emerged behind the nucleus can not be found their source regions. In total, we therefore found about thousand events but only 65% has its related source regions.

3. Results

3.1 The statistical analysis of the outbursts

Using the definition of the morphology classification [2], we found almost the same ratio in type A, B and C and two of them are changing their type (i.e. from A to B) during the outburst. Most of the detected outbursts (71.1%) appeared in the early morning and 28.9% occurred after the local noon. The frequency of the outburst (Figure 1) in inbound orbit (from July 10 to Aug. 12) is about twice more than that in outbound orbit (from Aug. 12 to Sept. 5).

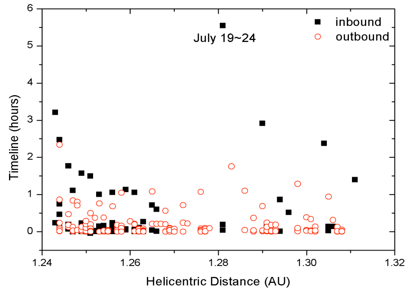

Figure 1 The timeline analysis in the inbound (black-square) and outbound (red-circle) orbits.

Although some outbursts from comet 67P were detected only by a single image, we can estimate how long the outbursts have last. The mean duration for the detected outbursts from July 2015 to September 2016 is about 15 minutes. The longest event was found on the October 31, 2015 and it was lasting 3 hours more.

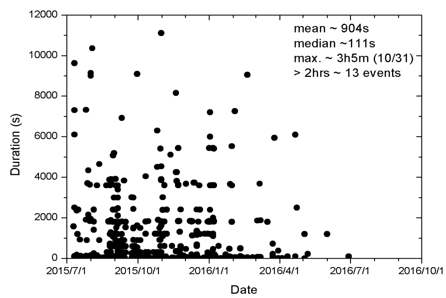

Figure 2 The duration analysis during the entire mission (from July 2015 to September 2016).

3.2 The excess brightness for outburst plumes

A ring masking technique is used to calculate the excess brightness of the outbursts. The calculated excess brightness from these outburst plumes ranges from a few percent to 28%. According to Lin et al. (2015) [3], the excess brightness from the coma jet activities in 2014 when comet 67P was at the heliocentric distance of 3.53–3.29 au was 3–10 per cent. When comet 67P moved closer to its perihelion in 2015 August, the excess brightness from the coma jet activities increased to 10–25 per cent of the uniform coma at a heliocentric distance of 1.24–1.38 au.

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